The documentation and process conversion measures necessary to comply with this revision shall be completed by 25 June 1995

INCH-POUND

MIL-S-19500/501B
25 March 1995
SUPERSEDING
MIL-S-19500/501A
1 April 1982

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER
TYPE 2N6051, 2N6052 JAN, JANTX, AND JANTXV

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for PNP, Darlington, silicon, power transistors. Three levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figure 1 (TO-3).

1.3 Maximum ratings.

	P_T 1/		V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_{op} and T_{STG}
	T_C = +25°C	T_C = +100°C						
	W	W	V dc	V dc	V dc	A dc	A dc	°C
2N6051	150	75	80	80	5	12	0.2	-55 to +175
2N6052	150	75	100	100	5	12	0.2	-55 to +175

1/ Derate linearly at 1.00 W/°C above T_C > +25°C.

1.4 Primary electrical characteristics.

	h_{FE2} 1/ V_{CE} = 3 V dc I_C = 6 A dc	h_{FE3} 1/ V_{CE} = 3 V dc I_C = 12 A dc	h_{fe} V_{CE} = 3 V dc I_C = 5 A dc f = 1 kHz	$\lvert h_{fe} \rvert$ V_{CE} = 3 V dc I_C = 5 A dc f = 1 MHz	C_{obo} 100 kHz ≤ f ≥ 1 MHz V_{CB} = 10 V dc I_E = 0	Pulse response	
						t_{on}	t_{off}
					pF	µs	µs
Min	1,000	150	1,000	10			
Max	18,000			250	300	2	10

	$V_{BE(sat)}$ I_C = 12 A dc I_B = 120 mA dc 1/	$V_{CE(sat)1}$ I_C = 12 A dc I_B = 120 mA dc 1/	$V_{CE(sat)2}$ I_C = 6 A dc I_B = 24 mA dc 1/	$R_{\theta JC}$
	V dc	V dc	V dc	°C/W
Min				
Max	4.0	3.0	2.0	1.00

1/ Pulsed, see 4.5.1

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: NASA/Parts Project Office (NPPO) NASA Goddard Space Flight Center, Code 310.A, Greenbelt, MD 20771-3917 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Printing Services Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500 and on figure 1 herein. No aluminum case shall be permitted.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-S-19500. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-S-19500.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500.

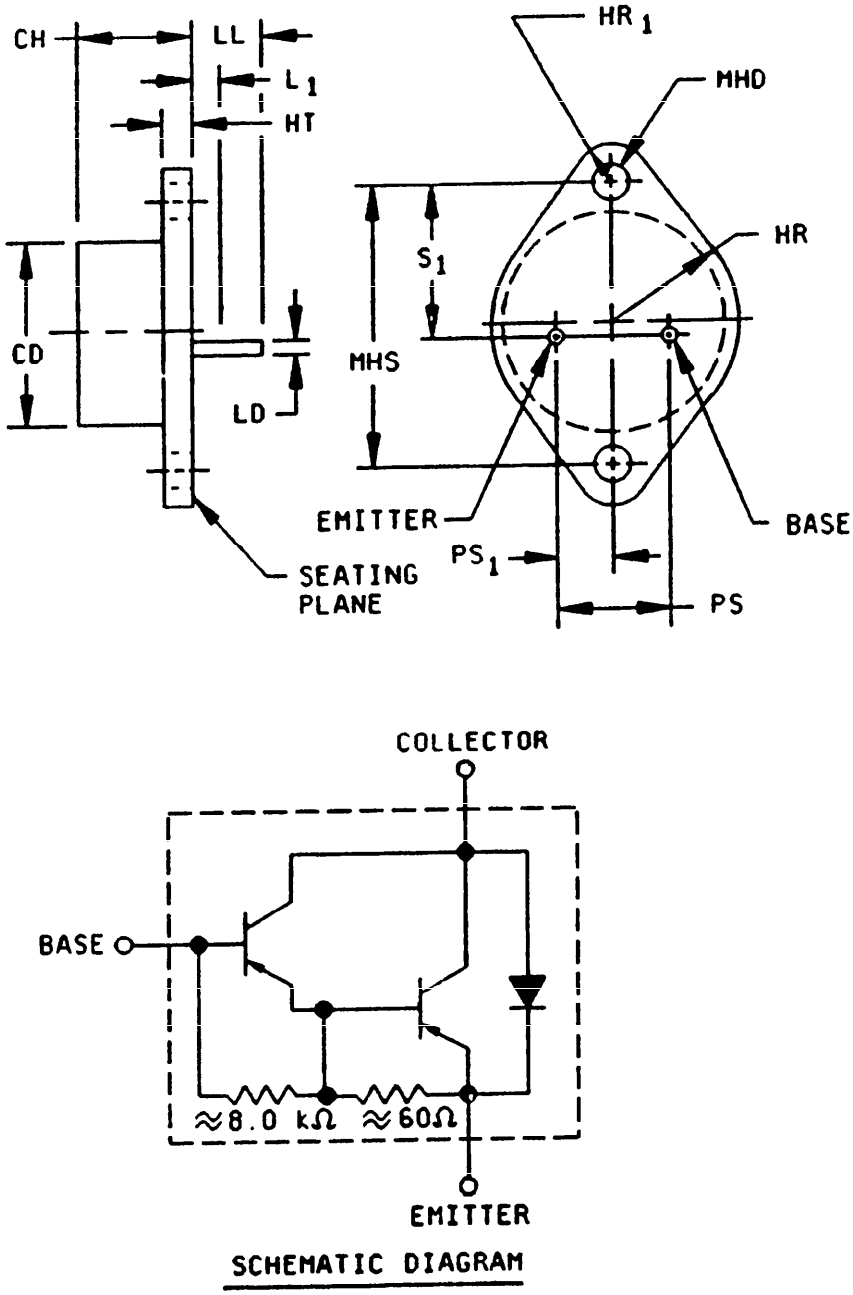


FIGURE 1. Physical dimensions and schematic circuit.

Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CH	.250	.328	6.35	8.33	
LD	.038	.043	0.97	1.09	5,9,11
CD		.875		22.23	3,11
PS	.420	.440	10.67	11.18	4, 10
PS_1	.205	.225	5.21	5.72	4,5,10
HT	.060	.135	1.52	3.43	
LL	.312	.500	7.92	12.70	5
L_1		.050		1.27	5, 9
MHD	.151	.161	3.84	4.09	7,11
MHS	1.177	1.197	29.90	30.40	
HR	.495	.525	12.57	13.34	
HR_1	.131	.188	3.33	4.78	6
s_1	.655	.675	16.64	17.15	4

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Body contour is optional within zone defined by CD.
4. These dimensions shall be measured at points .050 inch (1.27 mm) to .055 inch (1.40 mm) below the seating plane. When gauge is not used, measurement shall be made at seating plane.
5. Both terminals.
6. At both ends.
7. Two holes.
8. The collector shall be electrically connected to the case.
9. LD applies between L_1 and LL. Diameter is uncontrolled in L_1.
10. The seating plane of the header shall be flat within .001 inch (0.03 mm), concave to .004 inch (0.10 mm), convex inside a .930 inch (23.62 mm) diameter circle on the center of the header, and flat within .001 inch, (0.03 mm) concave to .006 inch (0.15 mm), convex overall.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions and schematic circuit - Continued.

4.3 Screening (JANTX and JANTXV only). Screening shall be in accordance with table II of MIL-S-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurements
	JANTX and JANTXV levels
9	I_{CEX1}
11	I_{CEX1}, h_{FE2}; ΔI_{CEX1} = 100 percent of initial value or 100 μA dc; whichever is greater.
12	See 4.3.1
13	Subgroup 2 of table I herein; ΔI_{CEX1} = 100 percent of initial value or 100 μA dc, whichever is greater. Δh_{FE2} = ±40 percent of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

T_J = +162.5°C ±12.5°C; $V_{CE} \geq$ 10 V dc, $T_A \leq$ +100°C.

NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVb (JAN, JANTX and JANTXV) of MIL-S-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2.1 Group B inspection, table IVb (JAN, JANTX and JANTXV) of MIL-S-19500.

Subgroup	Method	Conditions
B3	1037	$V_{CB} \geq$ 10 V dc; ΔT_J = between cycles ≥ +100°C. $t_{on} = t_{off}$ = 3 minutes for 2,000 cycles. No heat sink or forced-air cooling on the devices shall be permitted.
B5	3151	$R_{\theta JC}$ = 1°C/W (maximum).

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.3.1. Group C inspection, table V of MIL-S-19500.

Subgroup	Method	Conditions
C6	1037	$V_{CB} \geq$ 10 V dc; ΔT_J between cycles ≥ +100°C. $t_{on} = t_{off}$ = 3 minutes for 6,000 cycles. No heat sink or forced-air cooling on device shall be permitted.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage, collector - emitter	3011	Bias condition D; I_C = 100 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6051				80		V dc
2N6052				100		V dc
Collector - emitter cutoff current	3041	Bias condition A; V_{BE} = 1.5 V dc;	I_{CEX1}			
2N6051		V_{CE} = 80 V dc			0.5	mA dc
2N6052		V_{CE} = 100 V dc			0.5	mA dc
Collector - emitter cutoff current	3041	Bias condition D	I_{CEO}			
2N6051		V_{CE} = 40 V dc			1.0	mA dc
2N6052		V_{CE} = 50 V dc			1.0	mA dc
Emitter - base cutoff current	3061	Bias condition D; V_{EB} = 5 V dc	I_{EBO}		2.0	mA dc
Base - emitter voltage (nonsaturated)	3066	Test condition B; V_{CE} = 3 V dc; I_C = 6 A dc	V_{BE}		2.8	V dc
Base - emitter voltage (saturated)	3066	Test condition A; I_C = 12 A dc; I_B = 120 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		4.0	V dc
Collector - emitter voltage (saturated)	3071	I_C = 12 A dc; I_B = 120 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		3.0	V dc
Collector - emitter voltage (saturated)	3071	I_C = 6 A dc; I_B = 24 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		2.0	V dc
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 1 A dc; pulsed (see 4.5.1)	h_{FE1}	1,000		
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 6 A dc; pulsed (see 4.5.1)	h_{FE2}	1,000	18,000	

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 12 A dc; pulsed (see 4.5.1)	h_{FE3}	150		
Subgroup 3						
High-temperature operation:		T_A = +150°C				
Collector - emitter cutoff current	3041	Bias condition A; V_{BE} = 1.5 V dc;	I_{CEX2}			
2N6051		V_{CE} = 80 V dc			5.0	mA dc
2N6052		V_{CE} = 100 V dc			5.0	mA dc
Collector - emitter voltage (saturated)	3071	I_C = 6 A dc; I_B = 24 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)}$		2.0	V dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 6 A dc; pulsed (see 4.5.1)	h_{FE4}	300		
Subgroup 4						
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = 3 V dc; I_C = 5 A dc; f = 1 kHz	h_{fe}	1,000		
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 3 V dc; I_C = 5 A dc; f = 1.0 MHz	$\|h_{fe}\|$	10	250	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}		300	pF
Pulse response						
Turn-on time		(See figure 3); V_{CC} = 30 V dc; I_C = 5 A dc; I_B = 20 mA dc	t_{on}		2.0	µs
Turn-off time		(See figure 4); V_{CC} = 30 V dc; I_C = 5 A dc; I_{B1} = I_{B2} = 20 mA dc	t_{off}		10	µs

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Safe operating area (dc)	3051	T_C = +25°C +10°C -0°C; t ≥ 1 s; 1 cycle; (see figure 3)				
Test 1		V_{CE} = 12.5 V dc; I_C = 12 A dc				
Test 2		V_{CE} = 30 V dc; I_C = 5 A dc				
Test 3						
2N6051		V_{CE} = 70 V dc; I_C = 200 mA dc				
2N6052		V_{CE} = 90 V dc; I_C = 155 mA dc				
Safe operating area (switching)	3053	Load condition B; (clamped inductive load); T_A = +25°C; $t_r + t_f \leq 1.0$ µs; duty cycle ≤ 2 percent; t_p = 1 ms; (vary to obtain I_C); R_s = 0.10 Ω; R_{BB1} = 80 Ω; V_{BB1} = 16 V dc; R_{BB2} = 100 Ω; V_{BB2} = 1.5 V dc; I_C = 12 A dc; V_{CC} = 20 V dc; $R_L \leq 2$ Ω; L = 10 mH; (Stancor C-2688 or equivalent)				
2N6051		clamp voltage = 80 +0, -5 V dc				
2N6052		clamp voltage = 100 +0, -5 V dc Device fails if clamp voltage not reached				
Endpoint electrical measurements		See table II, steps 1 and 5				
Subgroups 6 and 7						
Not applicable						

1/ For sampling plan, see MIL-S-19500.

TABLE II. Groups A, B, and C electrical measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Collector - emitter cutoff current 2N6051 2N6052	3041	Bias condition A; V_{BE} = 1.5 V dc; V_{CE} = 80 V dc V_{CE} = 100 V dc	I_{CEX1}		0.5	mA dc
2.	Collector - emitter cutoff current 2N6051 2N6052	3041	Bias condition A; V_{BE} = 1.5 V dc; V_{CE} = 80 V dc V_{CE} = 100 V dc	I_{CEX1}		1.0	mA dc
3.	Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 6 A dc; pulsed (see 4.5.1)	h_{FE2}	1,000	18,000	
4.	Forward-current transfer ratio	3076	V_{CE} = 3 V dc; I_C = 6 A dc; pulsed (see 4.5.1)	Δh_{FE2}	±40 percent		

1/ The electrical measurements for table IVb (JAN, JANTX and JANTXV) of MIL-S-19500 are as follows:

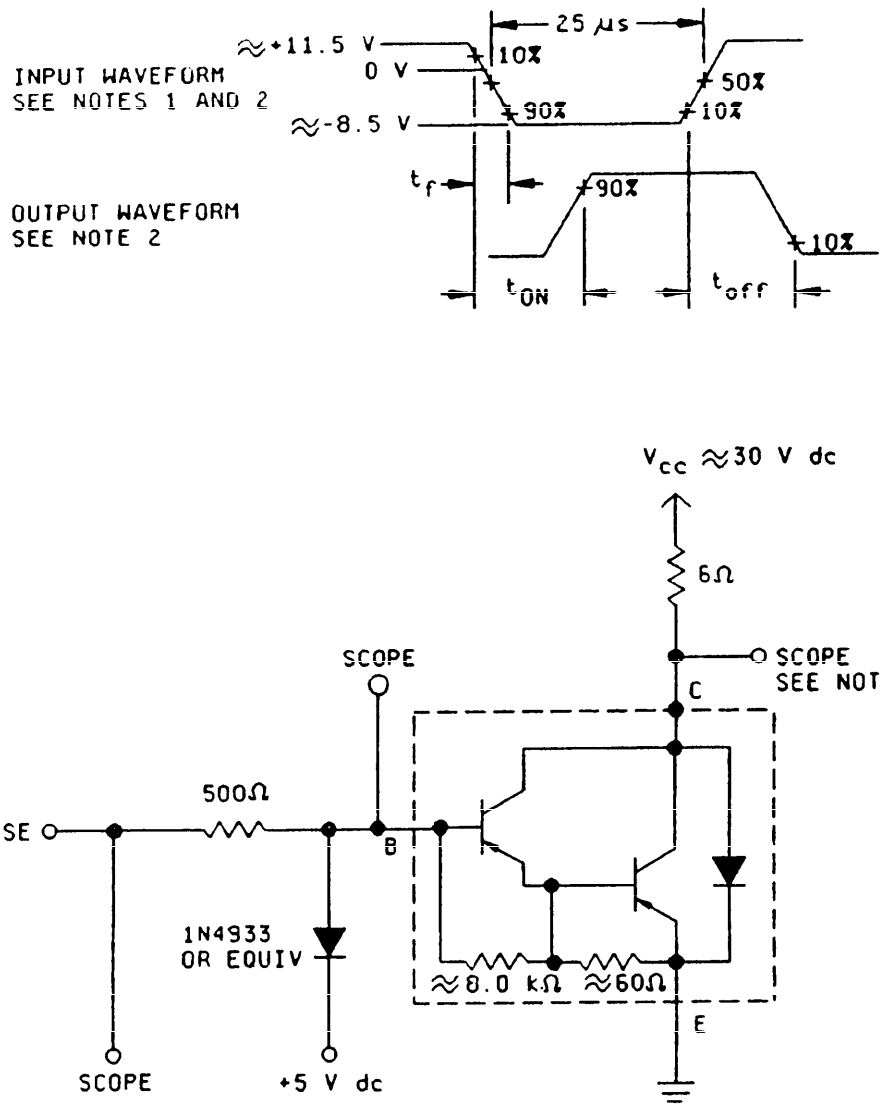
a. Subgroup 2, see table II herein, steps 1 and 3.

b. Subgroups 3 and 6, see table II herein, steps 2 and 4.

2/ The electrical measurements for table V of MIL-S-19500 are as follows:

a. Subgroup 3, see table II herein, steps 1 and 3.

b. Subgroup 6, see table II herein, steps 2 and 4.



NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 20$ ns, $t_f \leq 20$ ns, $Z_{out} = 50\ \Omega$, PW = 25 µs, duty cycle ≤ 2 percent.
2. Output wave forms are monitored on an oscilloscope with the following characteristics: $t_r \leq 2.0$ ns, $Z_{in} \geq 20$ kΩ, $C_{in} \leq 11.5$ pF.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

FIGURE 2. Pulse response test circuit.

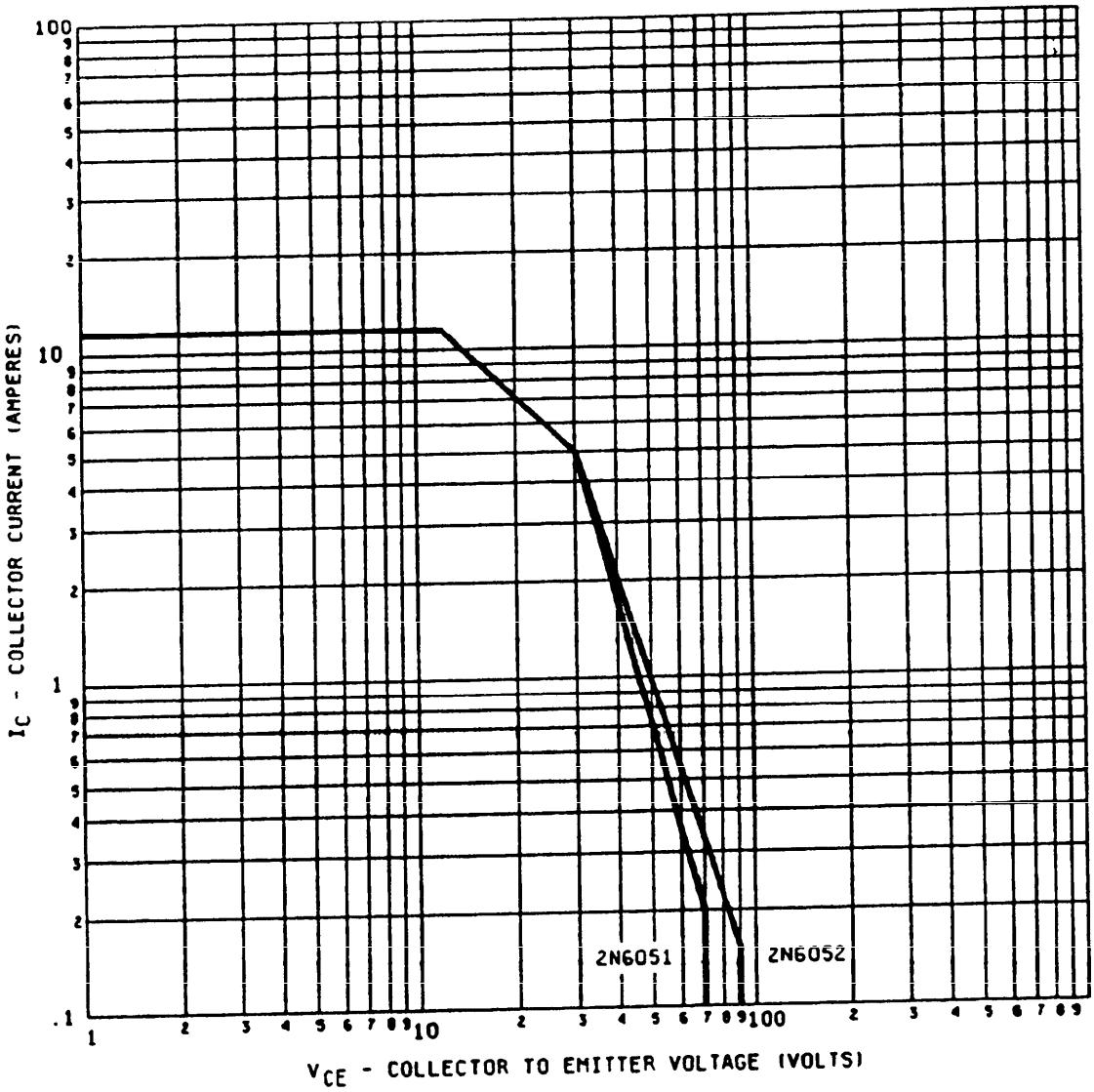


FIGURE 3. Maximum safe operating area graph (continuous dc).

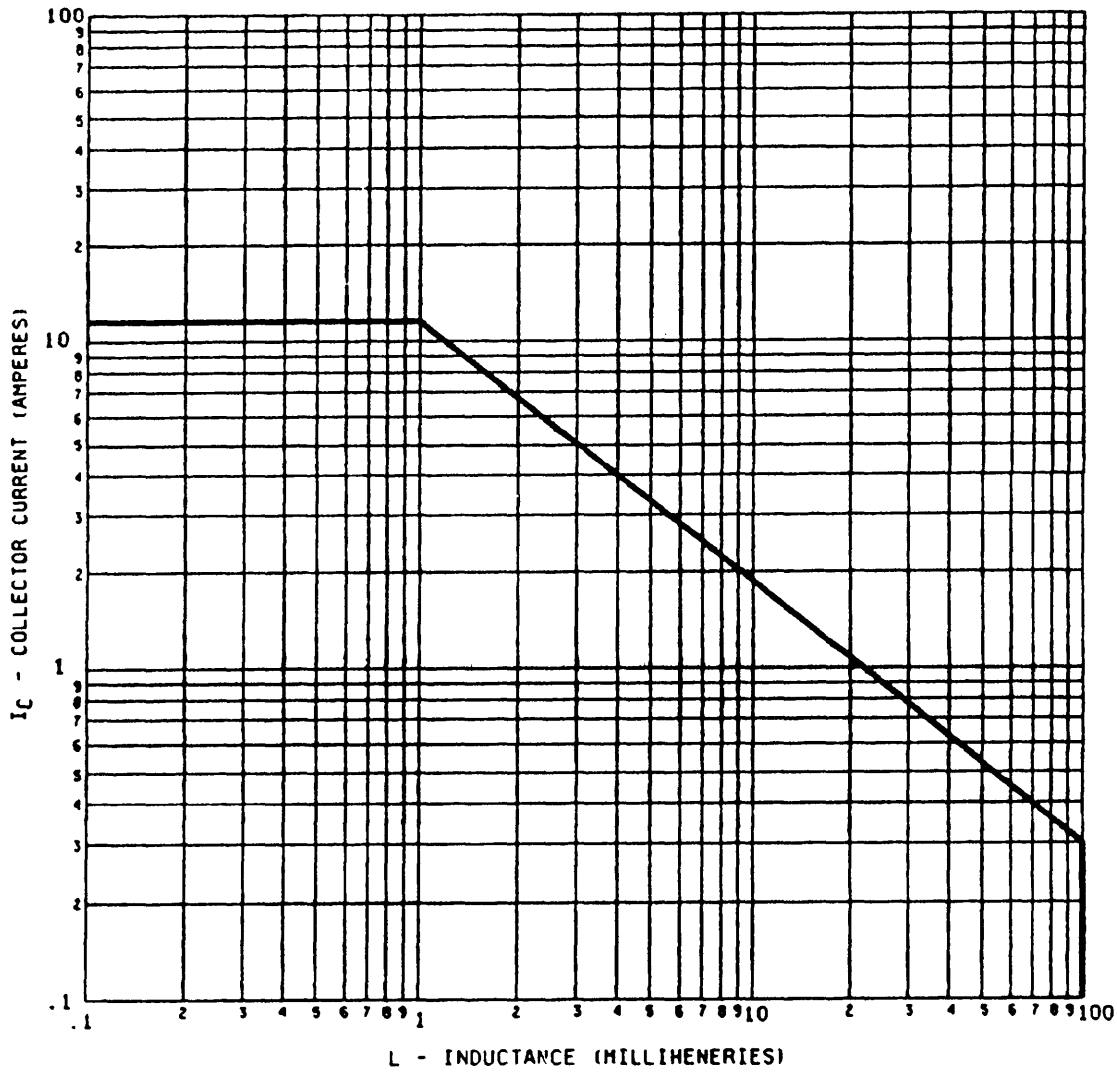


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish as specified (see 3.3.1).

c. Type designation and product assurance level.

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Air Force - 13, 15, 19, 85, 99

Preparing activity:
DLA - ES

Agent:
DLA - ES

(Project 5961-1744)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-S-19500/501B	2. DOCUMENT DATE (YYMMDD) 950325

3. DOCUMENT TITLE
SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER, TYPE 2N6051, 2N6052 JAN, JANTX AND JANTXV

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (if applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON
c. ADDRESS (Include Zip Code)	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340